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Agricultural Research

Poinsettias—A Seasonal Wonder!

A Blooming Industry

Poinsettias Lead the Way in Sales

Shops, homes, churches, and hotels blossom with the rich crimsons and scarlets of poinsettias as the winter holidays come around each year. Outside may be Florida's tender winter or Chicago's blizzards, but indoors the showy, brilliant colors of the poinsettia have become the red in traditional Christmas red and green—just as mums are the emblem of Mother's Day and lilies a symbol of Easter.

Not only is poinsettia the most popular Christmas plant, it is now the number-one flowering potted plant in the United States, even though its traditional sales period is just 6 weeks.

But in 1959, the wholesale value of poinsettias was a modest $8.9 million. In 1976, when Agricultural Research Service investigations had just begun to blossom, the wholesale worth of poinsettias was $37.6 million. Last year, the wholesale value of the poinsettia crop reached nearly $170 million—a jump of more than 400 percent from 1976.

The market has grown like this because it can depend on having millions of poinsettias ready—in long-lasting bloom—all at once.

Such dependability does not happen by letting nature take its course. To be able to plan ahead to synchronize the blooming of such masses of plants requires both precise knowledge of the conditions that govern their growth and flowering and the ability to repeat those conditions year after year—in other words, scientific information. And it requires plants genetically dependable enough for a whole industry to rest on generating most of a year's income all in one short burst.

Last year, the wholesale value of the poinsettia crop reached nearly $170 million—a jump of more than 400 percent from 1976.

Developing that kind of dependability requires research that growers are rarely in a position to carry out. Discovering the exact conditions of light, temperature, and growing regimen requires the tightly controlled conditions found in laboratories and experimental greenhouses—and scientists able to spend years checking the effects of the smallest change.

Since plants do not carry pedigrees, basic research and breeding development are rarely noted by the public. But without such contributions, many flowers would never have become such major sellers.

In particular, ARS scientists helped provide the sci-

PAUL ECKE

Commercial poinsettia production in California.

Seasonal Symbol From Mexico

The poinsettia, a contemporary symbol of Christmas in many parts of the world, was introduced to the United States and named after Joel Robert Poinsett in 1825.

Poinsett was serving as the first U.S. ambassador to Mexico when he saw the plant growing on the hillsides of Taxco, a small town in southern Mexico, where the plant is native.

Taxco was called Cuetlaxochitl by the Aztecs, who prized poinsettias and considered them a symbol of purity because of their brilliant red color.

The Aztecs made a reddish-purple dye from the colored "flowers," which are actually modified leaves called bracts. They also made a medicine against fevers from the latex sap of the plant.

In the 1600's, Franciscan priests came to Taxco and began using poinsettias in the Fiesta of Santa Pesebre, which is a nativity procession. The appearance of the red bracts coincided with the time of the procession.— **J. Kim Kaplan**

entific information that helped the poinsettia into the multimillion-dollar industry it is today.

ARS researchers performed breeding experiments that defined how color develops in poinsettias, and they devised precision growing methods.

"ARS contributions have been very significant for the poinsettia industry," says Carolyn Mack, spokesperson for the Poinsettia Growers Association. "In particular, the cooperative efforts of distinguished ARS researchers such as Robert Stewart and Marc Cathey have been extremely helpful to the commercial hybridizers."

How It All Got Started

In the 1950's, poinsettias would appear each year in hotel lobbies and other public areas shortly before Christmas. But those plants were expensive to produce and most kept their leaves and color only a few days.

Then, Robert N. Stewart, at the time a geneticist in ARS' Florist and Nursery Crops Laboratory in Beltsville, Maryland, became interested in improving poinsettias. (He has since retired.)

Stewart began by looking at "keeping quality"—the length of time that poinsettias will remain presentable. "Most of what growers produced before I started working was beautiful when it left the greenhouse, but it just didn't last," Stewart says.

"What brought poinsettias to my attention were the scientific meetings that used to be held mostly between Christmas and New Year's. The hotel lobbies would be all dressed up with poinsettias," Stewart explains. "But by the end of a meeting, I'd notice all the leaves had dropped off the plants."

Poinsettias also held scientific interest for Stewart and other ARS scientists because they are an "excellent plant for testing purposes—extremely useful in the laboratory," he says.

They are evolutionarily primitive plants that cannot be crossbred with other species. This makes their physiology easier to study than that of complex, hybrid plants.

KIM KAPLAN

But poinsettias are also difficult to work with because they produce only one seed for every three breeding crosses, rather than many, like wheat or corn.

Most poinsettia propagation is done from cuttings, and small changes and advances come from sports—genetic aberrations or mutations.

Stewart found that most of the commercial poinsettia varieties grown in the 1950's were tetraploids—meaning that each plant had four sets of genes, which made developing new varieties from conventional crossbreeding even more difficult.

But he located a few that were diploids—two sets of genes—that appeared to have longer keeping quality.

From these, he developed several different varieties that looked beautiful and had staying power. "We had great names: Rudolph, for the reindeer, Ruff and Reddy; Stoplight was maybe be our best name," Stewart remembers.

To separate poinsettias genetically so that his breeding work would be as precise as possible, Stewart called on ARS plant physiologist Sam Asen for help.

Asen identified and characterized the pigments that give poinsettias their distinctive colors, using what was then a very new tool called a microspectrophotometer assembled by Karl Norris.

Norris was part of the ARS team that found phytochrome, the plant pigment that serves as a biological light switch controlling flowering and other plant functions. He developed the microspectrophotometer to measure spectral (light refracting) properties, which can identify chemical components in a substance.

"From that information, I was able to develop fingerprints of poinsettias by quantifying their pigments—a sort of chemotaxonomy," Asen says.

He found that the pigments that give poinsettias their characteristic colors are anthocyanin-flavonoid complexes. The colors of these complexes are also greatly influenced by the acidity of the cells' vacuoles where the pigments reside.

"Once we had these quantified, it was easy to tell cultivars apart," Asen said, "which made it easier for Bob (Stewart) to track genetic differences."

Stewart also worked on genetically segregating such traits as branching stiff stems, deep coloration, and larger bracts. These petal-like bracts are really modified leaves that change

color; poinsettias' true flowers are tiny, button-shaped structures in the center of the stems.

Once Stewart had improved plants that met his standards, he needed to find ways to evaluate their keeping quality—not under the controlled conditions of a greenhouse, but under the irregular treatment of home and office care.

But how do you purposely handle plants the way they would be treated in shops and homes?

"Around Christmas each year, we would take three or four poinsettias around to each laboratory and office as tests and then keep careful records of how they lasted," Stewart says. "Our problem became not one of finding opportunities to evaluate plants, but of everyone wanting to get plants near Christmas time."

One winter, to test his varieties' keeping quality under low light and low temperature, he had hundreds moved outside between the rows of greenhouses. "Of course, that was the year it didn't get below 50°F all winter," Stewart adds.

How the Industry Grew

Once he had poinsettias with good color and keeping quality, Stewart started making them available to any grower who was interested in acquiring the germplasm. Growers then continued the work, breeding their own special varieties incorporating the qualities of Stewart's poinsettias.

"I got rid of a lot of the genetic garbage that was in the old poinsettias," Stewart says. "And my work literally forced the whole industry in the direction of diploids and good keepers."

Although no commercial variety grown today is directly Stewart's, there was a time when even the U.S. judicial system recognized his contributions.

"Two growers, one I think was from overseas, had sued over the ownership of—and the royalty due on—a poinsettia variety that was a very good keeper," Stewart remembers. "The conclusion of the court was that it must have originated in our breeding program in Beltsville because the judge had seen our large body of work in this area and he decided it had to be ours. In this case, he was wrong."

But improved keeping quality has not been ARS' sole poinsettia research accomplishment.

PAUL ECKE

In the 1960's, horticulturist H. Marc Cathey, then head of the Florist and Nursery Crops lab, began using poinsettias as a model in his investigations into the fundamental chemical control of plant growth. His work later branched out into the effects of light, temperature, and other stresses on poinsettias.

"What I found was a chemical treatment that would reduce internodal length—the distance a stem lengthens between leaf nodes—without delaying flowering or causing any other changes," Cathey explains.

"Height control was always a problem in poinsettias for commercial growers. They used to bend the stems around wires in an S-shape to make them look full enough. And from our standpoint, the plant was a worthwhile research model because it was so difficult to grow," Cathey adds.

The first compound that Cathey found that worked to retard internodal lengthening was related to Amo 1618, a disinfectant chemical developed for WWII and later reviewed for its biological activity. "I got Old Spice (Shulton Company) to make some chemical variations for me," he remembers.

Eventually, he found several compounds that commercial growers could use to keep their poinsettias from getting leggy. "All of them were replaced as time went along by more effective compounds," Cathey explains. "But at the time, this work had a major impact on helping poinsettias become a large industry."

From growth control, Cathey became involved in scientifically quantifying the conditions needed for poinsettias to come into bloom exactly when the market required.

To help the industry, he needed to know not only how to cause them to flower, but also how to stop them from flowering too soon.

Cathey found that exposing poinsettias to 3 seconds of light every minute—or 3 minutes every hour—from 11 p.m. to 1 a.m. each night held the plants on the brink of flowering until the grower was ready to ship.

He also helped develop other directions for growing poinsettias—from the quality and intensity of light, to the temperatures needed for blooming.

In the 1960's and 1970's, Cathey ran a national testing program with the cooperation of growers to evaluate growing conditions and new varieties. It continued until the "basic conditions

for commercial production were completely set down."

It would be hard to point to ARS' specific contributions to each poinsettia variety because so much progress has been made since the original research, but "the industry certainly learned a lot from what we did in USDA," Cathey said. "And they wouldn't otherwise have had access to the type of pioneering laboratory work we did in basic plant biology."

What About the Future?

Today, plant physiologist Donald T. Krizek, with ARS' Climate Stress Laboratory, uses poinsettias as one of his model plants as he investigates the effects of drought and atmospheric changes such as air pollution and ultraviolet radiation.

"In the 1970's, we became interested in the effects of ultraviolet radiation, largely because of the U.S. Department of Transportation's concern that supersonic airplanes might cause damage to the ozone layer in the upper atmosphere," Krizek explains.

He and retired horticulturist Pete Semeniuk found one of the groups of pigments that Sam Asen had identified from poinsettias and other plants—the flavonoids—was very important in protecting plants from the harmful effects of ultraviolet radiation.

These pigments, which occur within the surface of the leaf, serve as optical screens protecting the internal tissues from damage by UV radiation," Krizek explains.

Poinsettias have also served as a convenient model for finding out how the number and size of stomates—pores through which plants exchange gases—affect the plants' ability to deal with air pollution.

Poinsettia varieties are extremely sensitive to air pollutants; even a little sulfur dioxide can injure them.

Krizek and Semeniuk discovered that the fewer stomates a plant has, or the smaller the stomate openings, the more it can resist damage from pollutants.

While Krizek's interest has recently been in developing a scientific understanding of how all plants differ in their tolerance to air pollution, his work has also benefited poinsettia growers.

"I often get calls from growers who have had a whole greenhouse of poinsettias just die on them and they want to know why," Krizek says. "What I found was that most greenhouses use kerosene-powered heaters. Sometimes the kerosene is not as pure as it should be, and sulfur dioxide is produced."

Since many poinsettia varieties are extremely sensitive to air pollutants, even a little sulfur dioxide can injure them. Mystery solved!

Krizek and Semeniuk also found another factor that may be useful to growers. Exposing poinsettias to mild stress early in their growth can protect them from much greater stress later.

"Five days at cool temperatures, 68°F, when the bracts are developing can protect the plants against later damage from sulfur dioxide or other air pollutants," Krizek says.—By **J. Kim Kaplan,** ARS.

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PAUL ECKE

Hedging Against Erosion

Switchgrass in a laboratory test channel gives agricultural engineer Don Meyer (left) and agronomist Seth Dabney a chance to measure its sediment-trapping capability in a controlled environment. (K4836-5)

Stiff grasses could be a low-tech solution to a widespread problem.

Just as grasses planted along beaches protect sand dunes from wind and water erosion, stiff grasses could help U.S. farmers solve a major problem—protecting valuable topsoil.

In India in 1988, two World Bank agriculturalists extolled the virtues of using live hedges of vetiver grass *(Vetiveria zizanioides)* for controlling water erosion and argued their merits over U.S. bulldozer-built terraces. Doral Kemper, national program leader for soil management, was there with other ARS experts as an adviser on soil management technology for the U.S. Agency for International Development.

"It was a somewhat humbling experience," Kemper recalls. "As representatives of the country that has mounted the most extensive erosion control effort on planet Earth, we were less than wholly receptive to the message of the World Bank agriculturalists. They were saying that bulldozer-built terraces like those we use in the United States disturb topsoil and take water away too quickly—rather than letting it soak in. And that vetiver grass hedges do a better job of controlling erosion and conserving water—at much less cost—than terraces formed by earthmoving equipment."

With the aid of literature and slides, these vetiver enthusiasts provided strong evidence that the grass was fulfilling these claims in India, the West Indies, and Fiji.

"Slim, green rows of vetiver grass planted by farmers across hillsides 10 to 30 years ago grew into thick, sturdy grass hedges 9 feet tall and 6 to 7 feet wide. They slowed runoff significantly and deposited sediment," Kemper says. "Over the years, these deposits have formed wide, productive bench terraces uphill from the hedges."

Stateside, Kemper, working with cooperators at USDA's Soil Conservation Service (SCS), found out more about the grass. Until the mid-1940's, vetiver was grown in the southern states and was prized for its valuable roots containing an aromatic oil used for making long-lasting perfumes. After chemists found out how to synthesize perfume, commercial production of the grass practically ceased.

Seeds of vetiver collected in that era were found by ARS agronomist Gilbert Lovell at the Regional Plant Introduction Station, Griffin, Georgia. Some of those seeds were still viable after almost 40 years in storage.

Next, Kemper and SCS national plant materials specialist Curtis Sharp called together interested ARS, SCS, and university personnel to coordinate research and development activities on grass hedges for controlling erosion.

The group soon learned that using grass hedges is not a new idea here either. About 40 years ago, SCS proposed using hedges for developing natural terraces on steep lands.

SCOTT BAUER

"We're not sure why the idea didn't catch on," Kemper says. "We suspect that farmers were in a hurry to get their terraces built and earthmoving equipment became readily available to do the job. Since the government subsidized the construction of terraces, farmers adopted the quick alternative."

The group began testing different types of vetiver grass at a dozen U.S. locations to find out whether it would live up to World Bank expectations.

"All the vetiver types grew well over the summer. But winter freezes killed most stands," Kemper says, "except for several hedges planted by SCS plant materials specialist Mike Materne across shallow gullies at Fort Polk, Louisiana, where U.S. Army tank maneuvers had denuded extensive areas. There, the 100-foot-long vetiver hedges not only flourished, but caught sediment 18 inches deep on the upslope side in just a year."

Evaluating Other Grasses

Materne's findings were so encouraging that the group began a search for other grasses with stiff stems that wouldn't bend over when water ponds up against them and that are adapted to the climates of various U.S. regions.

Kemper found one candidate grass growing outside his office at the Beltsville Agricultural Research Center, Maryland. He had been watching an ornamental silvergrass, *(Miscanthus sinensis* Andersson), grow thick, closely packed stems and survive several cold winters.

Also thriving in nearby plantings were several closely related silvergrasses planted in 1980 by ARS' Jack Murray and Kevin Morris, of the National Turf Grass Association. They provided vegetative silvergrass to Materne, who multiplied it in Louisiana plots during the winter months and made it available to all who needed it the following spring.

In 1991, silvergrass hedges were tested on erosion plots near Oxford, Mississippi. About a month before cotton planting, clumps of 1-foot-tall grass from Materne were planted about 7 inches apart and uphill from the lower ends of 72-foot-long plots with 5-percent slopes.

"Just one row of the grass held back nearly half of the soil lost or eroded from plots without hedges," says Keith McGregor, ARS agricultural engineer at the USDA National Sedimentation Laboratory in Oxford.

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Technician Tommy Winter measures the height of a grass hedge at the lower end of a cotton plot while agronomist Alan Hudspeth records the data. (K4838-19)

From May through September, about 14 tons an acre of soil were lost on grass-hedged plots that were conventionally tilled compared to 24 lost on plots without hedges. On untilled plots, these losses were 0.7 tons with hedges versus 1.3 without.

McGregor says, "A 5-percent slope is enough for runoff to cause serious erosion during rainstorms. Longer slopes in fields would cause even more soil to erode."

"Soil accumulated as far as 10 feet uphill from the grass hedges in just a year," he says. "It was fertile soil that would have been lost if it had been on unprotected cottonfields."

"How hedges work to protect fields is simple," explains McGregor. "As gaps between the hedges fill in, more water ponds up uphill from the hedges, more sediment is deposited in these ponds, and less soil and water are lost from the field."

He says that plans are to continue the study for at least 2 more years.

Another candidate the group found was switchgrass *(Panicum virgatum* L.), which showed promise for controlling both wind and water erosion.

ARS agronomist Seth Dabney, the Oxford project's grass expert, is testing several types of silvergrass and switchgrass as hedges. Last summer, he planted ten 3-foot-wide strips of switchgrass seed across the slopes of a 20-acre soybean field.

"We wanted to see under field-scale conditions how well the stiff-grass strips held back concentrated runoff water that would flatten most grasses," Dabney says.

"We've established a stand, but switchgrass grows slowly for the first year or so. The young hedges are not yet stiff enough to stand up against the concentrated runoff near the bottom of the field." Dabney is working with local farmers to develop practical methods to establish and manage hedges to best control erosion.

Using grass hedges will also help to maintain water quality downstream. "Any conservation practice that leaves more of the soil in place on the land also improves the water quality of our streams and lakes," McGregor says.

Dabney adds, "Hedges planted on the contour give farmers a guide to farm along. And by temporarily ponding runoff, hedges may be able to hold sediment on fields where crop residues must be turned under to prevent build-

up of insects and diseases or to control weeds where herbicide applications are a problem."

Past research under the direction of Oxford ARS agricultural engineer Don Meyer with finer stemmed grasses like tall fescue, *Festuca arundinacea,* and bermudagrass, *Cynodon dactylon,* showed their ability to trap sediment from shallow flows. However, they were flattened by deeper flows.

"A major challenge now," says Meyer, "is to find grasses that will stand up to deeper concentrated flows coming off large, sloping fields."

Former ARS research associate, Gale Dunn, who worked with Dabney, evaluated the ability of grass hedges to slow runoff water in a test channel at the Oxford lab.

"We found that all the 2-year-old vetiver, silvergrass, and switchgrass types we tested were strong enough to pond flowing water up to 1 foot deep," Dabney says. "While all these grasses grow tall and erect, more important for hedges than plant height is an increase in the size and number of tillers—sprouts from the base of the stem. Tillers help fill in the gaps between plants and slow the flow. Large tillers give hedges stiffness so they don't bend over in deep flows."

Meyer and Dabney are building a new test channel where they will study different types of hedges to see how crop residues and sediment in runoff affect the amount of water ponded and the length of time it remains.

Kemper says that grass hedges are also being studied at several other ARS labs.

- Based on 25 years of research by ARS soil scientists Al Black and J. Kristian Aase at the ARS Northern Plains Soil and Water Research Center, Sidney, Montana, Kemper is convinced that grass hedges will also help control wind erosion.

Aase says that "Hedges of tall wheatgrass, *Elytrigia elongata,* seeded at 50-foot intervals, reduce wind velocity at the soil surface and provide protected areas where loose soil particles stay settled. Otherwise, unsettled particles become projectiles that blast additional particles loose to become airborne."

He says that in the northern plains, hedges also trap snow. Some waterborne sediment from their rare runoff events is deposited in the draws, causing terraces to form across the hedges.

- Near Big Springs, Texas, where only about 17 inches of rain fall a year, ARS agronomist James D. Bilbro is finding that hedges of Alamo switchgrass grow over 6 feet tall and have dense tillers and deep rooting.

"Growing cotton on these sandy soils makes them extremely vulnerable to wind erosion," says Bilbro. "In this semiarid area where crop residues are generally in short supply and the potential for wind erosion is quite high, switchgrass hedges can certainly reduce soil loss from wind erosion."

- Also adding to our knowledge of how to use grass hedges effectively to control erosion are studies by ARS agricultural engineer Larry Kramer at Deep Loess Research Station near Traynor, Iowa, and soil scientist E. Eugene Alberts on claypan soil erosion study plots near Columbia, Missouri.

Kramer has established a switchgrass hedge on a 15-acre corn field of highly erodible soil with slopes of up to 16 percent. He's using silvergrass plantings to reinforce the hedge where it must stand up to concentrated runoff.

"Perennial grass hedges don't grow quickly, so time is needed to give them the opportunity to show what they can do," Kemper said. "This time we're not going to let our impatience keep us from completely evaluating this technology!"—By **Hank Becker,** ARS.

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SCOTT BAUER

Water runoff from a cottonfield, having passed through the grass hedge behind agronomist Alan Hudspeth, is recorded on a hydrographic chart. (K4838-1)

Cattle and Sheep Relish Nutritious Globemallow

Globemallow, a hardy plant with brilliant orange-red flowers, might be a perfect addition to a drought-tolerant garden. It may also provide a new food choice for sheep and cattle.

"Livestock are like humans—they like variety in their diets," says Melvin D. Rumbaugh, a plant geneticist in the Agricultural Research Service's Forage and Range Research Unit in Logan, Utah.

Because globemallows bloom from spring until the first frost, they can lengthen the grazing season. "That means ranchers could spend less money on hay to supplement sparse fall forage," adds Rumbaugh.

Globemallows belong to the *Melvacea,* or mallow, family which includes cotton, hollyhocks, and marshmallows—a pink-flowered herb from Europe. (The sticky, sweet confections of the same name originally contained ground-up marshmallow roots.)

Native to North America, globemallows grow wild in the western states, from Arizona to the Canadian border, but would probably do well in many arid or semiarid environments, says Rumbaugh. "These plants can get by on as little as 6 inches of rain a year," he says, "so they're a perfect addition to a drought-tolerant landscape or garden. And their bright color makes them an attractive ornamental."

Sheep will eat both flowers and leaves of globemallows, according to the results of a 4-year grazing trial near Kimberly, Idaho.

In the spring, sheep ate globemallows as readily as crested wheatgrass and alfalfa—two common pasture species. Globemallows will grow, however, where it's too dry for alfalfa, says soil scientist Henry F. Mayland.

Mayland, with the ARS Soil and Water Management Research Unit in Kimberly, helped Rumbaugh with the grazing trials.

Globemallows may also remedy a serious problem in cattle known as grass tetany, or hypomagnesemia. Caused by a magnesium deficiency, the ailment usually occurs in early spring when cattle graze on fresh, tender young grasses that often contain an imbalance of nutrients that diminish magnesium availability.

Roughly 3 percent of cattle in temperate rangelands display the chronic symptoms of grass tetany: reduced weight gain and lowered milk production. In rare, acute cases animals suffer tremors, coma, or even death.

Globemallows, like alfalfa, contain enough magnesium and calcium to meet the dietary needs of both cattle and sheep, says Mayland. "So seeding globemallow along with crested wheatgrass may reduce cases of grass tetany."

USDA's Soil Conservation Service (SCS) is interested in planting globemallows along roadsides, notes Rumbaugh. Because some species put out underground stems, or rhizomes, they spread quickly—a feature that helps stabilize soil on sloped roadbanks.

Rumbaugh plans to identify and breed globemallow varieties that are most promising as forage plants. He hopes to make seeds of these varieties available to plant nurseries within the next 2 years. They in turn would supply seeds to agencies responsible for rangeland seeding, such as USDA's Forest Service, SCS, and the Department of the Interior's Bureau of Land Management.

Other varieties may be released for landscaping and gardening.—By **Julie Corliss,** ARS.

RICHARD SHAW / UTAH A.E.S.

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Rescuing a Popular Nut From Attack

Long before Europeans arrived on this continent, Native Americans enjoyed the exceptional taste of nuts produced by majestic, wild pecan trees.

The nutritious pecan—the most important of the hickory *(Carya)* species—lends its rich, nutty flavor to luscious confectioneries such as pecan pie.

And Agricultural Research Service scientists are guardians of this American contribution to the world of fine foods.

"We're working to protect pecans from diseases and insects," says ARS horticulturist Bruce W. Wood. "And we're trying to make the crop more productive."

At the Southeastern Fruit and Tree Nut Research Laboratory in Byron, Georgia, Wood leads a team of horticulturists, plant pathologists, and entomologists trying to solve the disease and insect problems confronting southeastern pecan growers.

Pecan production in this region dropped to 83 million pounds in 1990, less than half the 173 million grown there in 1988. Much of this decline is attributed to diseases.

KEITH WELLER

Looking somewhat like missile nose cones scattered through this pecan orchard, insect traps monitor pecan weevil populations for entomologist Louis Tedders (left) and technician John Blythe. The weevils are attracted by differing values of reflected light from the Masonite trap bases. (K4871-7)

Pecans: In addition to protein and carbohydrate, pecans provide dietary potassium, phosphorus, magnesium, and calcium, as well as small amounts of the trace elements zinc, manganese, and copper. While the kernels are about 70 percent fat, 95 percent of the fat is unsaturated.

Total U.S. production has not followed the same trend: in 1990 it was 205 million pounds and in 1991, 299 million. The forecast for 1992 is 205 million.

Fungal diseases plague pecan crops in the humid Southeast. So much so, says ARS' Charles C. Reilly, that the pecan industry is a significant user of fungicides.

This is because the strategy for managing pecan diseases is based on controlling pecan scab, the number-one disease problem that threatens both foliage and fruit. Other fungal diseases are considered secondary and are usually taken care of by the fungicides applied to control scab.

However, this may not be the case with a recently discovered disease.

"After several days of rain in August 1988, I noticed signs of rot around the stem ends of some of the pecans on trees here at the station," says Reilly, a plant pathologist at Byron. "Within a day or two, the rot had circled the shuck and moved all the way to the tip of the fruit."

Within 4 days, the pecans were rotted. Closer inspection showed the shucks (the immature nut's hard, green covering) had become almost black and were moist and spongy.

A New and Virulent Disease

"I realized then that we weren't dealing with pecan scab, which attacks both the leaves and fruit," Reilly says.

His investigation and further research identified a new disease, which he named *Phytophthora* shuck and kernel rot. Already, this disease, caused by *P. cactorum* and spread by

rain, was cutting yields up to 50 percent in some orchards in south and central Georgia.

"The surprising thing was that those orchards were well managed, irrigated, and mature," Reilly says.

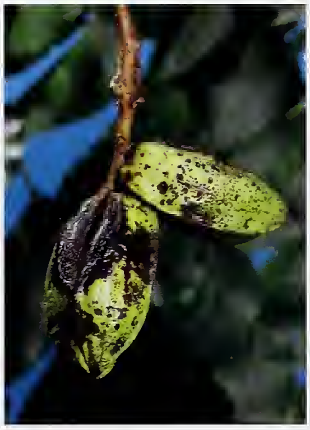
A soilborne fungus, *P. cactorum*, can destroy the whole crop if it develops early in September. Damage from later infection (late September) results in discolored nuts, which reduces kernel quality.

Early identification of the new disease is difficult, according to Reilly, because the rot begins on isolated nut clusters throughout the tree. Growers can suspect *Phytophthora* shuck and kernel rot if there are "sticktights" on the pecan trees in mid-August after prolonged periods of rain. A sticktight is the infected, discolored pecan shuck, dried and adhering tightly to the pecan shell.

Temperature is also important for this fungus to grow, he says. Wet, cool days with temperatures between 50°F and 88°F are ideal for the disease. Threat of the disease is decreased in months when the weather is very hot or very dry. The fungus has been found in orchard soils throughout the Southeast and can infect pecan roots. It's thought that insects that spend part of their life cycle in the soil may move the fungus into the 100-foot-tall trees.

Fortunately, the disease can be managed by judicious application of existing fungicides registered for use on pecans.

SCOTT BAUER



Stem blight has blackened large patches on these pecans. (K4867-11)

A Disease So New It's Unnamed

Reilly has identified an even newer disease that was first noticed on last year's crop.

"We know that this disease is caused by a fungus in the genus *Phomopsis*, but we haven't identified the particular fungus," he says.

This new disease, as yet unnamed, not only causes the nut to rot, but also causes dieback of twigs on which the fruit forms. Dieback occurs when the infection moves into the stem and destroys the part of the tree to which the fruit is attached.

Stress, such as heavy fruit set or drought, seems to increase the severity of the disease.

Reilly has found this disease in pecan orchards he sampled throughout Georgia. One reason for the widespread occurrence could be that many of the leading commercial pecan varieties are very susceptible to the pathogen.

Fungi in the genus *Phomopsis*, he says, are very common worldwide. They are spread by rain splashing from infected parts of the tree.

The new disease can be controlled, Reilly suggests, with the same fungicides used against pecan scab.

"Although, in the past, pecan growers have considered pecan scab their primary concern, this new information proves that *Phytophthora* shuck and kernel rot, the *Phomposis* disease, and pecan anthracnose—a long-known disease that has recently become more severe —can destroy the crop too," Reilly reports. "This demands a rethinking of control measures."

For example, since growers have always concentrated on controlling scab, they apply their last cover spray of fungicides in early August.

"Unfortunately, this leaves pecans unprotected from September through harvest, which is from late October through November," says Reilly.

Bad Bacteria and Bugs Team Up

In addition to identifying two new diseases and rediscovering an old one, Reilly has clarified another problem for growers.

He has shown that a bacterium—*Erwinia herbicola*—is associated with late-season nut drop and kernel disorder. *E. herbicola* is normally present on pecans.

Nut loss during the water stage and early shell hardening (July through

August) has been attributed to various conditions. Demands on the tree during this stage create extreme stress and may cause what is called physiological fruit abortion.

It so happens that this same period is when the pecan is most appealing to two insects—stinkbugs and the hickory shuckworm.

pecan growers in Georgia alone about $25.8 million in 1990.

"Aphids," says entomologist W. Louis Tedders at Byron, "are the major insect problem pecan growers face in the Southeast. And, interestingly, fire ants worsen the aphid problem."

Under almost every pecan tree in the Southeast there is a fire ant mound,

KEITH WELLER

At a test site in Dawson, Georgia, plant pathologist Charles Reilly checks the susceptibility of this pecan cultivar by coating fruit with pecan anthracnose spores. (K4624-11)

When Reilly examined internal damage in the dropped nuts, he found it remarkably similar. "The kernels were dark brown to black, shrunken, and slimy, regardless of whether the damage was inflicted by insects or simply resulted from the tree's physiology."

Since the bacteria are also present on healthy nuts, Reilly concluded that an injury such as insect feeding or some other kind of wounding activates the bacteria, allowing entry into the nuts.

"We're working on a control strategy that would reduce the incidence of disease by suppressing insect populations," he says. Insects cost

Tedders says. The ants rarely eat aphids, but prey on several beneficial insects that do. They forage in the trees and eat the eggs, larvae, and pupae of lacewings, thereby saving many pecan aphids from certain death.

The aphids seem to return the favor by excreting honeydew for the ants to eat. "We've seen ants forage as high as 40 feet into a pecan tree to get honeydew," Tedders says.

Three types—the yellow pecan aphid, the blackmargined aphid, and the black pecan aphid—are present in pecan trees in enormous numbers. All feed on foliage.

Sap that they suck from the leaves is rich in sugars. The aphids take amino acids and other nutrients from the sap for growth and reproduction and excrete the sugars. They deposit the sugars on the foliage in the form of honeydew.

Because aphids give birth to live young, the offspring immediately begin feeding and continue for the duration of their 3-week lifespan. This feeding draws much-needed vigor from the tree, since the sugars are essential for fruit production and good nut quality.

Aphids are rapidly becoming resistant to chemicals, so biological controls with lady beetles and other beneficial insects are being used against them more often.

"We developed this biocontrol method several years ago and many growers are using it already," Tedders says.

But the method takes some planning. Growers first plant crimson clover and hairy vetch on the orchard floor. These legumes harbor pea aphids that serve as prey for lady beetles and other beneficial insects.

After the legumes die in May and June, the lady beetles, deprived of their food source, move into the trees and feed on pecan aphids.

"This method works well because there are about 25 species of beneficial insects that appear with these cover crops," Tedders explains. They include assassin bugs, syrphid flies, pirate bugs, beneficial stinkbugs, and brown and green lacewings.

Since legumes and lady beetles last until June and the hot weather helps control aphids during midsummer, some means of protection is needed for the fall. It's at this time that Tedders uses another biocontrol technique—lacewings.

Tedders started experimenting with lacewings for aphid control a few years ago. Several companies now rear the same species commercially.

Hickory shuckworms, pecan nut casebearers, and stinkbugs also attack pecans. These pests lower the quality of mature nuts and cause loss of immature nuts.

Of the three, the stinkbugs are the only ones that have hosts other than pecan. They fly into the pecan orchard after cotton, soybeans, and corn crops are gone.

Insecticides are still used to control the nut casebearer and shuckworm, but the most effective ones are no longer available because of environmental concerns. Since the casebearer has many parasites, it is usually controlled biologically in the Southeast. But control of stinkbugs is difficult because nuts are usually harvested before their damage is discovered.

The insect pest most likely responsible for transporting fungi into the trees is the pecan weevil, Tedders says. This weevil spends part of its life cycle in the soil.

In midsummer, the adult weevil lays eggs in pecan nuts that are nearing maturity. The resulting larvae destroy the nut kernels. By this time, the grower has already made a substantial investment in the crop.

Mature larvae chew an exit hole in the nut, fall to the ground, and burrow into the soil. There they remain for 1 or 2 years, during which they pupate and become adults. Adults remain in the soil for another year before emerging.

Adult weevils, probably replete with the soilborne fungus, immediately crawl or fly into the pecan trees and mate, and the cycle begins again.

"There's simply no way to manage this pest while it's in the soil or in the nut," Tedders says. "It's protected in these stages."

Last year, Tedders designed a new type of trap that growers are already using to monitor weevil emergence.

Better monitoring means more effective control when spraying must be done. Although chemical control is available, Tedders says spraying also kills most of the beneficial insects. But knowing when the weevils peak in pecan orchards gives growers a better idea of whether and when to spray.

"Insects do more than just reduce quality of the current season's nut crop," says Bruce Wood, who is director of the Byron lab. "Aphid feeding on a tree can also affect that tree's production the following year."

ROB FLYNN

Biological aide Sharon Tucker releases lacewings from cages to control yellow and black pecan aphids. (K4625-14)

Sooty Mold Cuts Photosynthesis

A feeding aphid excretes honeydew, which contains carbohydrates and nitrogen, a perfect growth medium for microorganisms. As it builds up on leaves, a heavy black fungus called sooty mold soon proliferates.

"This is like laying a lead blanket over the leaves, blocking out sunlight that is essential for photosynthesis," Wood explains. "We've observed in some cases that this mold cuts light penetration to the leaf surface up to 98 percent."

Pecan trees have a relatively high late-season energy demand. So photosynthetic activity during the fall is critical to future nut production.

Rains can wash most of the mold from the trees, but in dry periods it becomes a major problem that fungicides don't completely control. Most growers don't have a control program for this mold, Wood says.

"What we're looking for is better aphid control. After all, it's the aphids that produce the honeydew that the fungus thrives on. And the long-term aphid populations haven't responded well to our attempted control with insecticides."

It's a vicious cycle.—By **Doris Stanley,** ARS.

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SCOTT BAUER

Improved Ginning for Better Cotton

Cotton ginning technology has changed a lot since March 14, 1794, when Eli Whitney won a patent for a new invention. The cotton gin—which would eventually transform the South's economy and, ultimately, the nation's politics—would also make cotton the "king" of U.S. crops.

Before Whitney's invention, only a slick-seeded cotton variety grown exclusively in Southern coastal regions could be easily cleaned of seeds by textile mills. But the advent of the cotton gin enabled the South to also grow higher yielding varieties.

By today's standards, Whitney's invention was a crude machine, consisting largely of a box in which two revolving cylinders—one covered with spikes and the other with a brush—combed the seeds out of cotton fiber. His cotton gin mechanized the labor-intensive task of manually separating the seeds, or "lint," so the cotton fiber could be sent to textile mills, spun into yarn, and woven into fabric.

Today, computerized improvements to Whitney's basic concept still have the same aims as the original: to increase farmer's profit, reduce labor costs, and provide textile mills with a higher quality raw product.

"Ginning today is more than just removing seeds from cotton," says W. Stanley Anthony, an agricultural engineer with the Agricultural Research Service and inventor of the improved technology. "A modern cotton gin does a lot more cleaning and conditioning to the fiber.

"Everything you do with cotton is important to its final quality and to what the farmer will be paid," he adds.

◀ **Agricultural engineer Stanley Anthony operates a microgin at the U.S. Cotton Ginning Laboratory in Stoneville, Mississippi. It is the only fully computer-controlled cotton ginning system in the world. (K4840-1)**

"We're trying to improve the odds for both the farmer and textile mills."

Because not all cotton is created equal, researchers at the ARS Cotton Ginning Research Unit in Stoneville, Mississippi, are looking at ways to gin cotton better, based on individual physical fiber properties.

Ginning involves the removal of trash, which includes any type of plant debris that becomes attached to cotton when it's picked from the field. Various ginning steps remove unwanted material both before and after seed is separated from the fiber.

SCOTT BAUER

Cotton on the right has been ginned and is ready for conversion into yarn at a textile mill. (K4844-9)

The ginner must also dry cotton to a recommended 6- to 7-percent moisture content, making it easier to separate trash from the fiber. But if the moisture content drops below that level, fiber quality diminishes, Anthony says.

All cotton in today's gins usually receives the same amount of cleaning, however trashy it might be. Factors such as weather during harvest and physical differences between varieties, or even between different fields, can make some cotton cleaner, dirtier, or more or less moist than other cotton.

Anthony and colleagues are developing new modifications to the ginning process so cotton will have to pass through only those cleaning steps that are really necessary.

Four patents were recently issued for a computerized ginning process control system that Anthony has invented.

"Our first task was to set up a system that could analyze trash content and recommend proper cleaning levels," Anthony says. "The computer model that we developed can help make decisions during ginning that can ultimately affect market price."

To determine what ginning steps are necessary to maximize farmer profit, the computer uses five pieces of information to calculate ideal ginning conditions. It looks at cotton moisture, trash content, color, cotton pricing structures, and gin machinery performance characteristics.

The model allows the ginner to process each batch of cotton through the minimum machinery necessary to achieve maximum returns, rather than uniformly processing all the cotton. Anthony says, "By using the computerized process, increased returns to the farmer typically range from $6.86 to $23.38 per bale."

Cotton market grade is based on color, trash content, preparation, fiber length, strength, and other quality factors—all of which can be influenced by ginning. When it is sold, a bale of cotton receives a grade based on these criteria. That grade determines how much the farmer will be paid for the bale.

In some cases, many cottons don't need to go through each drying or cleaning step, which could cut energy costs and decrease fiber damage. The primary energy cost is for electricity used to power the equipment.

Once the "brain" behind computerized ginning was developed, scientists turned to devising instruments that could detect information during ginning and transmit it to the computer model. Anthony uses infrared sensors to measure moisture and special video cameras to detect colors and trash as the cotton goes through cleaning and drying.

The cameras were originally developed for use in objective grading of ginned cotton lint samples.

"To control the drying process, sensors and cameras predict lint moisture, color, and trash content by scanning bulk seed cotton that contains both lint and cottonseed," Anthony says.

He paired the sensors and cameras at three locations in a pilot gin at the Stoneville lab: in the area where harvested cotton enters the gin, at a spot just before cotton enters the seed removal stage or gin stand, and at a location prior to baling. The computer controlled the dryer temperatures to ensure fiber quality and lower energy costs.

"Energy costs could be cut by half because the dryers weren't required to run at full throttle," Anthony says.

Cotton color is strongly influenced by weather exposure in the field. However, Anthony says that gin machinery like lint cleaners can blend fibers to help improve the grade.

As cotton travels through the gin, the cameras detect changes in color and trash and relay this information to the computer model. This allows the model to make ginning decisions that will result in the best possible blend in each bale of ginned cotton to help improve grade and farmer profit.

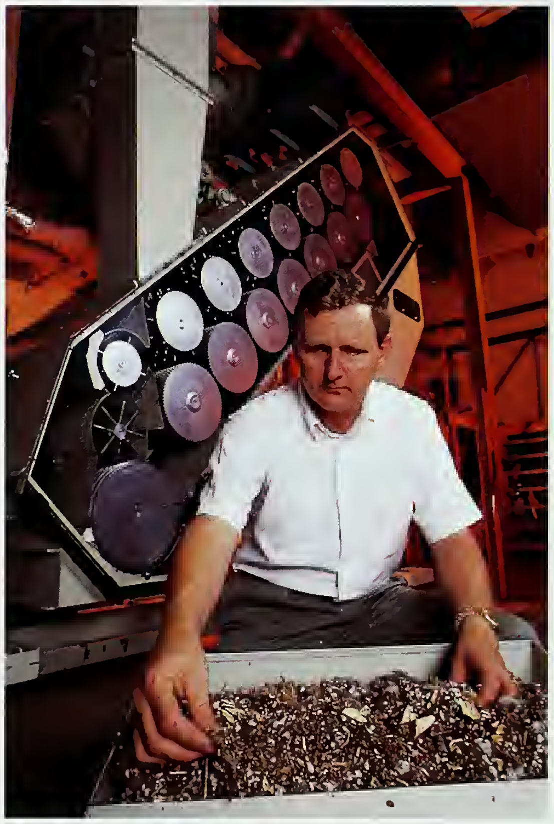
"The cameras are the eyes that allow the brain (computer) to decide which cleaning steps are necessary," Anthony says. "This helps to control valves in the ginning system that will route cotton through the right cleaning machines."

Cotton is conveyed through large pipes from one cleaning step to the next. To keep all the cotton from traveling through the entire system, Anthony installed valves that serve as pass gates.

For example, if cotton contains a lot of trash, the valves remain open and allow the cotton to go through all cleaning steps. But if the cotton is relatively clean, the cameras relay that information to the computer that directs the closing of a valve. This allows cotton to bypass a particular operation and travel to the next ginning step.

"Thanks to the special routing valves, the computer can decide whether to bypass or select any combination of four seed-cotton cleaners, two multi-path dryers, and three lint cleaners," Anthony says. "This is important because if cotton is overcleaned or overdried, fiber quality and farmer profits decrease."

SCOTT BAUER



Agricultural engineer Stanley Anthony inspects trash removed from cotton during the ginning process. About 100 pounds of foreign matter is cleaned from cotton for every 500 pounds of lint ginned. (K4841-4)

Since cotton is ginned in a continuous process, it was important for Anthony to ensure that rerouting cotton wouldn't create any traffic jams. In current ginning systems, as much as 50,000 pounds are ginned each hour.

"Computerized ginning is not something that is going to happen overnight," Anthony says. "It is going to essentially require ginners to completely overhaul their operations.

"While the computerized control is the best ginning system in the long run, initial installation costs could hurt many ginners financially—especially the smaller operations," he adds.

So in the interim, one of the patented features—the flapper—is being used as a component of the dryer-control system. It will likely be in use in many gins well before the complete process control system, Anthony says.

The flapper consists of a movable metal valve that works like a door, roughly 6 inches square and perforated with 3/8-inch holes. It can be attached on one of the pathways where cotton flows through the gin, either in the seed cotton or lint cleaning stages.

Because the flapper is perforated, air can flow through the holes when the door shuts, but cotton can't. The door catches the cotton and compresses it against the camera where it is analyzed.

The door then mechanically opens and releases the cotton. Information read by the camera is transmitted to the computer and used to determine the amount of drying or cleaning required.

While the ARS-computerized system may be somewhat costly, Anthony says several ginners have contacted him about the technology. Payback on investment could occur in less than 2 years.

And textile mills looking for high-quality, low-trash cotton to make finished goods may join the movement toward ginning systems capable of consistently producing higher grades of cotton.—By **Bruce Kinzel,** ARS.

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Blight Threatens Oregon's Hazelnuts

You'll find them in nut mixes, cookies, cakes, candies, and other holiday treats. They're even pressed to make a gourmet oil for salads, or ground into a creamy spread to top toast or crackers.

Hazelnuts—also known as filberts—are rich in protein and vitamins B-6 and E. Last year's crop of 25,000 tons was valued at more than $20 million.

A slow-moving blight, however, threatens European hazelnut trees in Oregon, where nearly all the U.S. crop is grown. ARS researchers are working to halt the blight and to preserve a unique collection of trees that may have some natural resistance to the disease.

"It's known as Eastern Filbert Blight, because in the eastern United States, a closely related shrub, called American hazelnut, harbors the blight-causing organism," says plant pathologist John Pinkerton who is in ARS' Horticultural Crops Research Unit in Corvallis, Oregon.

Although the blight causes only minor damage to the American shrub, it kills the European trees, which is why they haven't been grown commercially on the East Coast.

The disease showed up in southwestern Washington about 20 years ago. Since then, it has destroyed most commercial orchards there and has spread to about 6 percent of Oregon's hazelnut orchards.

Pinkerton has been monitoring the blight's movement in the Northwest for several years. He and colleagues Ken Johnson and Shawn Mehlenbacher at Oregon State University (OSU) seek better ways to stifle the blight and preserve Oregon's hazelnut industry.

Early symptoms of the blight are black, pimplelike pustules on the tree's twigs. The tiny football-shaped bumps—about the size of a BB—are caused by a fungus, *Anisogramma anomala.*

The bumps don't appear until about 14 months after the spores first drift onto the tree. And it can be several

MICHAEL THOMPSON

Dead branches reveal extent of Eastern filbert blight damage in hazelnut orchard near Boring, Oregon. (K4857-2)

years before an infected branch's leaves turn brown and wither—a phenomenon known as flagging because the leaves hang on like flags, even after the normal leaf drop in autumn.

MICHAEL THOMPSON

In research to find blight-resistant hazelnut varieties, plant pathologist John Pinkerton sprays Eastern Filbert Blight spores on young filberts in a greenhouse. (K4857-9)

Although the nuts are not affected by the fungus, diseased trees can die after 7 or 8 years.

Some weather factors, such as wind and rain, affect the disease's spread, says Pinkerton. Raindrops may wash fungal spores down to lower branches on the same tree. Rain splash and wind may carry the microscopic spores to nearby trees.

"We found that the blight tended to travel northeast— the same direction as the prevailing winds—both within and between the orchards," says Pinkerton. In these susceptible areas, researchers advise spraying trees each spring with fungicides to prevent wayward spores from taking hold. And in winter, says Pinkerton, orchardists should inspect each tree and prune and burn any suspicious-looking branches.

For his experiments, Mehlenbacher uses cuttings, seeds, and pollen supplied by the nearby ARS Clonal Germplasm Repository in Corvallis. It is the nation's official storehouse for filberts and half a dozen other crops, including berries, mint, pears, and hops.

Breeders use materials gleaned from the outdoor collection of 420 different trees. Inside the repository there are more—miniature hazelnut trees, no more than 5 inches high, growing on nutrient gels in heat-sealed plastic bags.

The bags are also a good way to ship filbert varieties to breeders around the world—from South Africa to Spain, says Barbara Reed, a plant physiologist who works at the repository. She and OSU graduate student Xiao Ling Yu perfected the technique to store the tiny trees.—By **Julie Corliss,** ARS.

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ARS' Accommodating GRIN

GRIN 3 may sound like the latest movie sequel, but it's not. Rather, it is the Agricultural Research Service's most recent effort to improve access to the Germplasm Resources Information Network's computer database by scientists, plant breeders, and curators who work with plant germplasm.

First used in 1984, the GRIN system has become a useful tool in helping researchers ensure the health and productivity of agricultural crops.

And now, plans are underway to upgrade database software and fit it with a more powerful computer and operating system, says Jimmie D. Mowder, manager of the Database Management Unit in Beltsville, Maryland.

Mowder says upgrading the current GRIN offers several advantages. For example, the new system will facilitate continued improvement of GRIN by allowing managers to make database changes more quickly.

GRIN 3 will process queries for data faster—in some cases, doing in minutes what used to take hours. At the same time, redesigned software coupled with the new system will better equip GRIN 3 to handle more users.

"I actually expect any scientist in the country to have direct access to GRIN," he says. "Once we go on the new system we won't be concerned about bogging down the old, existing one."

This switch will also aid in responding to another country's request for software used by GRIN. The U.S Department of Agriculture cooperates with the agricultural research centers of other nations in setting up similar information management systems.

GRIN 3 should become operational by 1994. In the meantime, the database management unit is putting the finishing touches on a personal computer version of GRIN containing selections of plant germplasm information.

"We can now take segments of data out of GRIN, put this package together as PC GRIN, and send it out to researchers who don't have access to GRIN," says Mowder. Provided on written request, PC GRIN allows a user access to germplasm data on personal computers without a modem and phone line.

GRIN presently contains information on over 410,000 accessions of germplasm collected, evaluated, and distributed by USDA's National Plant Germplasm System.—By **Jan Suszkiw,** ARS.

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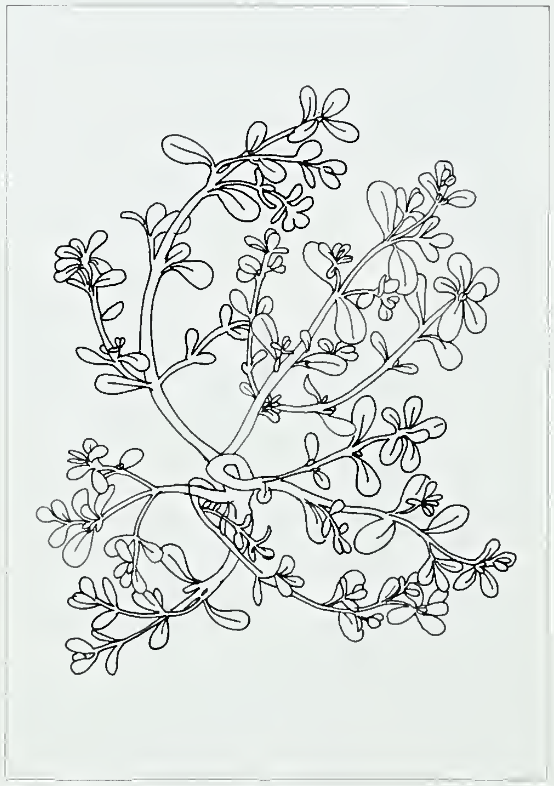

Purslane

Purslane Eyed As Rich Food Source

Hippocrates used it as a medicine. Henry David Thoreau found it in a cornfield, boiled it, and called it a "satisfactory dinner." Many Europeans today eat it as Thoreau did, or chop it up fresh and put it in their salads.

It's known as purslane—a plant that is a troublesome weed in many U.S. crops, especially vegetables. But recent research findings confirm that purslane is also a rich source of fatty acids, vitamin E, and other key nutrients—making it a prime candidate as a new vegetable crop.

There are about 200 species of purslane, the common name for a group of plants known as *Portulaca.* Scientists have focused on one annual species, *P. oleracea,* found around the world and in all 50 states. It is known for its persistence—it grows even in poor-quality soils with little water and resists disease. Its seeds have been found to survive for 40 years.

Researchers, including Helen A. Norman of the Agricultural Research Service in Beltsville, Maryland, have been conducting extensive studies of *P. oleracea* because of its high levels of omega-3 fatty acids. These nutrients, linked in some studies to reduced heart disease and other health benefits, are essential to building cell membranes, especially in the brain and eyes.

Humans and other mammals cannot make omega-3 fatty acids efficiently, so they must get them directly from food. Fish, a rich source of these fatty acids, obtain them by eating phytoplankton—minute, waterborne plants. Algae are high in essential dietary omega-3 fatty acids, while more advanced plants typically contain lower amounts.

But purslane is a major exception. Norman, at the agency's Weed Science Laboratory; James A. Duke at the ARS National Germplasm Resources Laboratory in Beltsville; Artemis P. Simopoulos of The Center for Genetics, Nutrition, and Health in Washington, D.C.; and scientist James E. Gillaspy of Austin, Texas, have confirmed that *P. oleracea* contains more of one omega-3 fatty acid—called alpha-linolenic acid—than any other green leafy vegetable yet studied.

Purslane can be eaten cooked or raw. In salads, it has a mild, nutty flavor and a crunchy texture much like bean sprouts. A 100-gram serving has about 300 to 400 milligrams of alpha-linolenic acid—10 times more than spinach, the researchers found.

Their findings were reported in the August 1992 issue of the Journal of the American College of Nutrition.

They've also discovered that purslane contains high levels of vitamin E—about 12.2 mg in a 100-gram

serving. That's six times more than spinach. Vitamin E is an antioxidant that protects cell membranes from breaking down.

Other researchers have reported that purslane is the only higher plant to contain eicosapentaenoic acid, another omega-3 fatty acid, but Norman says she has not been able to confirm that.

ARS research at the U.S. Salinity Laboratory in Riverside, California, reported in 1989-90, shows that purslane would be a possible alternative crop in arid areas of the southwestern United States, because it is adaptable to both dry conditions and to salty soils often present where land is irrigated.—By **Sean Adams,** ARS.

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Forecasting Dieters' Fat Loss

When Karen, 23, and Jennifer, 29 (not their real names), started on a 3-month, medically supervised diet together, they both wanted to lose at least 20 pounds.

They ate less and exercised more. They downed only half as many calories as they'd otherwise need to keep their pre-diet weight. And they huffed and puffed through treadmill workouts 6 days a week.

Three months later, after eating exactly the same foods, Karen had lost 31 pounds—7 more than Jennifer. Most (about 75 percent) of what Karen lost was fat, while nearly half of what Jennifer shed was water or muscle.

"Their difference in fat loss," says nutrition researcher Nancy L. Keim, "is significant because it's fat—not water or muscle—that you want to lose when you're dieting."

From monitoring Karen, Jennifer, and eight other women in an experiment at the ARS Western Human Nutrition Research Center in San Francisco, Keim and colleagues produced a new equation that predicts which dieters are likely to be faster—or slower—at shedding fat.

The equation relies on a lab measurement of free fatty acids in plasma, taken from a blood sample. Dieters who are likely to lose fat rapidly will have higher readings than others. To estimate weight loss, the free fatty acid measurement is plugged into the equation. The answer is then computed with a simple calculation that can be done by hand or with a pocket calculator.

The test can be administered within a few days after the dieter starts a weight loss program. It requires less than a teaspoon of blood, drawn after exercise but before breakfast. Most medical labs can process the sample.

The blood test for free fatty acids is frequently used in medical research, so it isn't new. But Keim's equation puts the test results to a new use: to yield an estimate of how many pounds of fat a dieter might shed on a 12-week weight-loss regimen. She developed the equation with co-researchers Teresa F. Barbieri and Marta D. Van Loan at the nutrition research center.

With further testing, the equation could give tomorrow's dieters an objective, scientific forecast of potential progress. "Dieters who know their prognosis," says Keim, "will be better prepared for what's ahead."

Too, nutritionists and physicians could use the equation to individually tailor diet plans and set more realistic goals for their patients. That's especially important for repeat dieters who find that with each new diet, it takes longer to lose weight.—By **Marcia Wood,** ARS.

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Slower Is Better

A 10-year study on rolling pastures in eastern Ohio has shown that methylene urea can help farmers comply with Environmental Protection Agency guidelines for drinking water.

Methylene urea fertilizer, developed by USDA scientists in the 1940's, is a polymer that is highly soluble in water. Its nitrogen is released to crops slowly as microorganisms break it down.

Lloyd B. Owens, an ARS soil scientist, says that the slow-release formulation helps keep some of the nitrate out of springs and wells used for drinking water.

After 10 years, springs in orchardgrass pastures fed with methylene urea tested at 7 to 14 parts per million of nitrate/nitrogen. Where ammonium nitrate was applied, water tested at 10 to 16 ppm. EPA guidelines for nitrate/nitrogen in drinking water allow a maximum of 10 ppm.

Both fertilizers were applied in three applications, for a total of 150 pounds per acre, a rate that is high but not uncommon, Owens says. Nationally, farmers use an average of 70 to 75 pounds of nitrogen fertilizer per acre each year.

"When ammonium nitrate was applied at a moderate rate—50 pounds per acre—the water tested at only 3 to 5 ppm," Owens says.

At 150 pounds per acre, the nitrate/nitrogen level in spring water remained at the 3 to 5 ppm level for the first 3 years, then increased sharply for the next 7 years.

Since the level of nitrate from the methylene urea stabilized closer to the allowable EPA level than that from ammonium nitrate, use of a slow-release fertilizer is one way to keep nitrate in the plant root zone longer, Owens says.

About 100,000 tons of methylene urea are used each year in turf and nursery applications. It costs about three times as much as urea, the most commonly used solid source of nitrogen. But this cost differential could be reduced if it became widely used for field crops.

"Although we can't control the weather, by changing the type and timing of fertilizer application, we can reduce the portion of nitrogen that is leached from the crop root zone," says Owens.—By **Don Comis,** ARS.

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